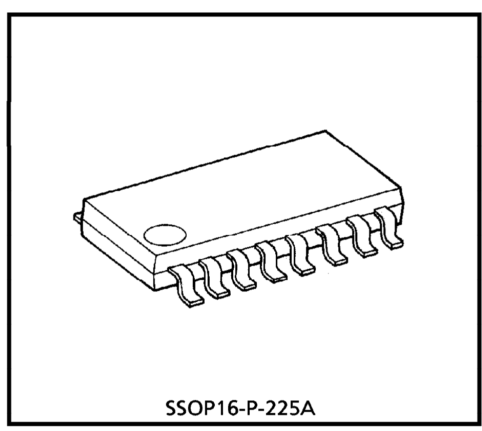
TOSHIBA BIPOLAR LINEAR INTEGRATED CIRCUIT

TA7688F

SILICON MONOLITHIC

STEREO HEADPHONE AMPLIFIER (3V USE)

The TA7688F is a stereo headphone power amplifier IC designed for portable cassette player applications.

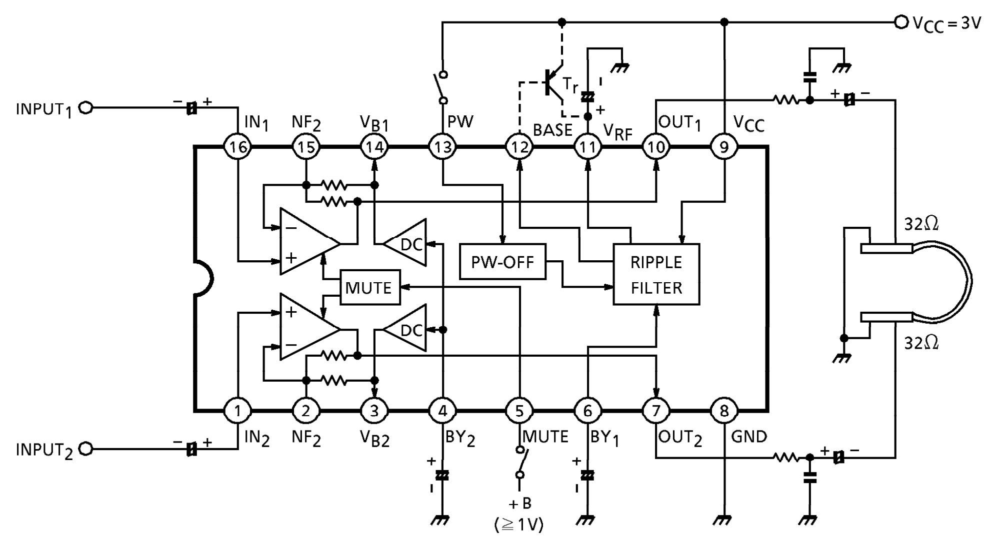


Weight : 0.14g (Typ.)

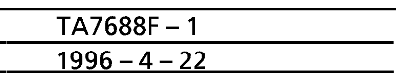
FEATURES

- Small installed area and few external parts
- Low supply current : $I_{CCQ} = 7mA$ (Typ.) at 3V
- Built-in a ripple filter
- Built-in a power amplifier mute
- Built-in a power off circuit
- Operating supply voltage range : $V_{CC\,(opr)} = 1.8\sim5V$
- Recommended supply voltage : $V_{CC} = 3V$
- The standard model is TA7688F (SO)

BLOCK DIAGRAM



Dotted Line is an additional circuit to boost the stabilized current. (Option)



APPLICATION NOTE

1. Voltage gain adjustment

The closed loop Voltage gain G_V is determined by the ratio of R_1 and R_2 shown in Fig.1.

$$G_V = 20\ell og \frac{R_1 + R_2}{R_2} = 32\text{dB}$$

But the actual value is 30.5dB because of influence of the other circuit.
Fig.2 showes the application circuit of higher or lower gain than recommended one.

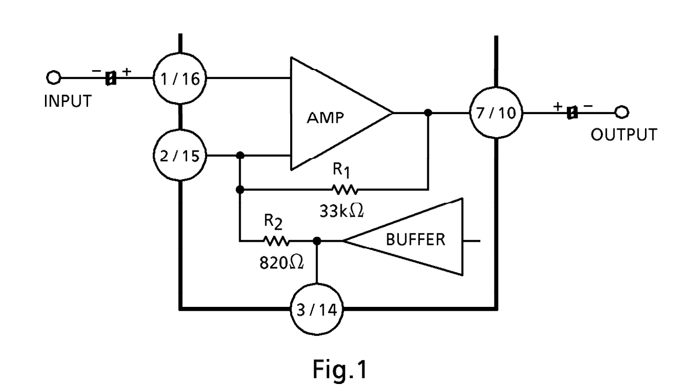
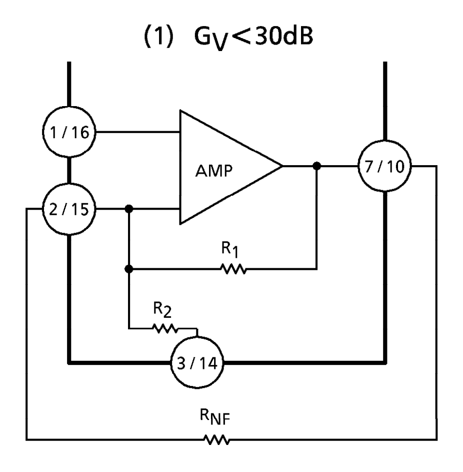


Fig.1

(1) $G_V < 30\text{dB}$



(2) $G_V > 30\text{dB}$

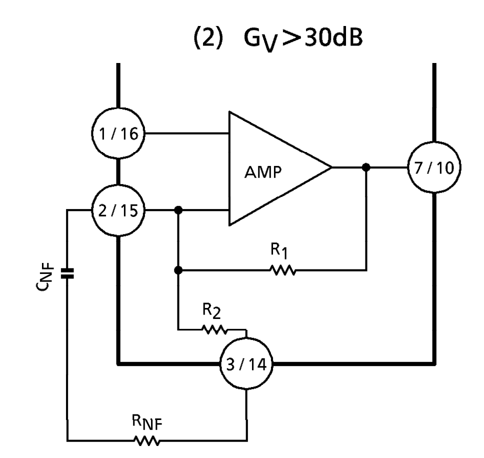


Fig.2

In the case of $G_V < 30\text{dB}$, it happens to oscillate by phase delay at high frequency.
So this IC is not available at $G_V < 30\text{dB}$. In the case of $G_V > 30\text{dB}$, input offset is amplified, so that output DC voltage differs from center voltage. The unsymmetrical clipping wave is prevented by inserting capacitor C_{NF}.
Therefore this IC is available at $G_V > 30\text{dB}$ by using C_{NF}.
It is recommended to check pop noise based on C_{NF}.

2. Muting

Muting operates when the voltage is applied to pin 5 or the current is flowed into pin 5.
Supply current is about half at muting ON.
It is necessary that muting drive current I_{MUTE} is less than 150μA.

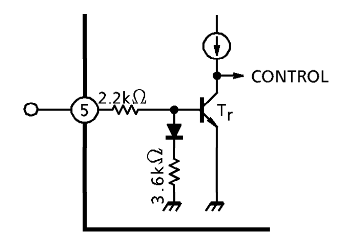


Fig.3

3. Oscillation precaution

(1) Oscillation preventing capacitor between output pin and GND is recommended to use capacitor with less temperature drift.
So suitable capacitor is not celamic or electrolytic capacitor, but tantalum or polyester film capacitor.
When protector resistor 3.9Ω is rejected, output power increases.
In this case, it is necessary to insert 3.9Ω as shown in Fig.4.
When $R_L = 0$, output current is very large in the circuit.

(2) It is necessary to use tantalum capacitor at Pin 11 (22μF) .

(3) Decoupling capacitor C_{10} is necessary to be near the pin 9.

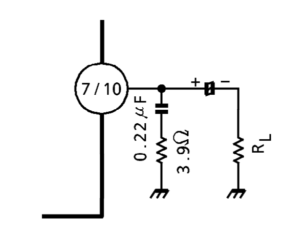


Fig.4

4. Radiation precaution

Because of wide band (about 200kHz), the radiation from the amplifier degrade S / N at radio. As shown in Fig.5, it recommended to limit the band by C and R.
In this case, phase compensation check is necessary.
When C = 100pF, R = 15kΩ, f_{HC} is 30~50kHz.

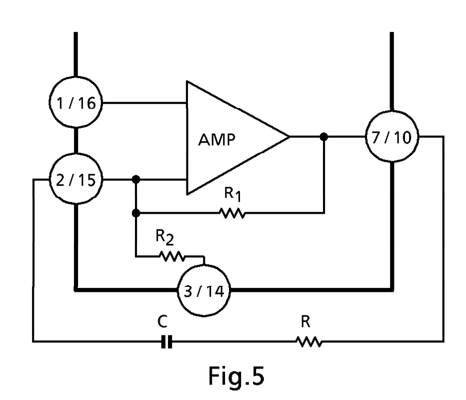


Fig.5

MAXIMUM RATINGS (Ta = 25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	7	V
Output Current	I_O	160 / ch	mA
Filter Output Current	I_R	10	mA
Power Dissipation (Note)	P_D	350	mW
Operating Temperature	T_{opr}	− 25~75	°C
Storage Temperature	T_{stg}	− 55~150	°C

Note : Derated above Ta = 25°C in the proportion of 2.8mW / °C.

ELECTRICAL CHARACTERISTICS

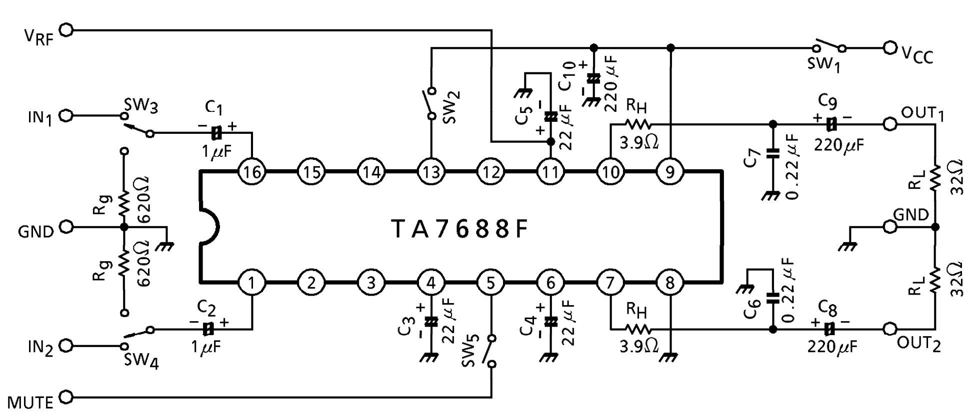
1. AC characteristics (Unless otherwise specified, Ta = 25°C, V_{CC} = 3V, R_g = 600Ω, f = 1kHz, R_H = 3.9Ω, R_L = 32Ω)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Quiescent Current		$I_{CCQ (1)}$	—	V_{in} = 0	—	7	12	mA
		$I_{CCQ (2)}$		V_{in} = 0, SW_2 : OFF	—	1	10	μA
Output Power		$P_{o (1)}$	—	THD = 10%	20	27	—	mW
		$P_{o (2)}$		R_L = 16Ω, THD = 10%	—	38	—	
Total Harmonic Distortion		THD	—	P_o = 10mW / ch	—	0.12	1.0	%
Closed Loop Voltage Gain		G_V	—	V_{in} = −42dBV	28.5	30.5	32.5	dB
Channel Balance		ΔG_V	—	V_{in} = −42dBV	—	0	± 1	dB
Cross Talk		CT	—	V_o = −2dBV, ch1↔ch2	45	65	—	dB
Ripple Rejection	Headphone AMP	RR (1)	—	f_r = 1kHz, V_r = −22dBV	30	45	—	dB
	Ripple Filter	RR (2)	—	f_r = 100Hz, V_r = −22dBV	—	40	—	dB
Output Noise Voltage		V_{no}	—	BPF = 20Hz~20kHz	—	0.06	0.2	mV_{rms}
Input Resistance		R_{IN}	—	f = 1kHz	15	20	25	kΩ
Ripple Filter Output Voltage		$V_{RF (1)}$	—	V_{CC} = 2V, I_{RF} = 10mA	1.45	1.6	—	V
		$V_{RF (2)}$		I_{RF} = 10mA	2.1	2.3	2.5	
		$V_{RF (3)}$		V_{CC} = 4.5V, I_{RF} = 10mA	—	3.4	—	
Muting Attenuation		ATT	—	V_{MUTE} = 3V (0dB = 240mV_{rms})	60	80	—	dB
Muting Input Voltage		V_{MUTE}	—	ATT ≧ 50dB (0dB = 240mV_{rms})	—	0.7	1.0	V
Muting Input Current		I_{MUTE}	—	ATT ≧ 50dB (0dB = 240mV_{rms})	—	35	—	μA
Ripple Filter Current		I_B	—	—	—	0.05	—	mA

2. DC characteristics
(Ta = 25°C, V_{CC} = 3V, Terminal voltage at no signal)

ITEM	SYMBOL	RATING	UNIT
Terminal 1 (IN_2)	V_1	1.5	V
2 (NF_2)	V_2	1.5	V
3 (V_{B2})	V_3	1.5	V
4 ($BYPASS_2$)	V_4	1.5	V
5 (MUTE)	V_5	0	V
6 ($BYPASS_1$)	V_6	2.2	V
7 (OUT_2)	V_7	1.5	V
8 (GND)	V_8	0	V
9 (V_{CC})	V_9	3.0	V
10 (OUT_1)	V_{10}	1.5	V
11 (V_{RF})	V_{11}	2.3	V
12 (BASE)	V_{12}	2.2	V
13 (PW ON / OFF)	V_{13}	3.0	V
14 (V_{B1})	V_{14}	1.5	V
15 (NF_1)	V_{15}	1.5	V
16 (IN_1)	V_{16}	1.5	V

TEST CIRCUIT



Note : R_H : Protection resistance
C_6 & C_7 : Tantalum capacitor or polyester film capacitor
C_5 : Tantalum capacitor

I_{CCQ}, V_{RF}, V_7 & V_{10} – V_{CC}

$R_L = 32\Omega$; I_{CCQ} (Mute OFF); I_{CCQ} (Mute ON); V_{RF} (I_{RF} = 10mA); V_7 & V_{10}

QUIESCENT CURRENT I_{CCQ} (mA) / OUTPUT TERMINAL VOLTAGE V_7 & V_{10} (V) / RIPPLE FILTER OUTPUT VOLTAGE V_{RF} (V) / SUPPLY VOLTAGE V_{CC} (V)

G_V – V_{CC}

$R_L = 32\Omega$, $V_{in} = -42$dBV, f = 1kHz

VOLTAGE GAIN G_V (dB) / SUPPLY VOLTAGE V_{CC} (V)

I_{CCQ}, V_{RF}, V_7 & V_{10} – Ta

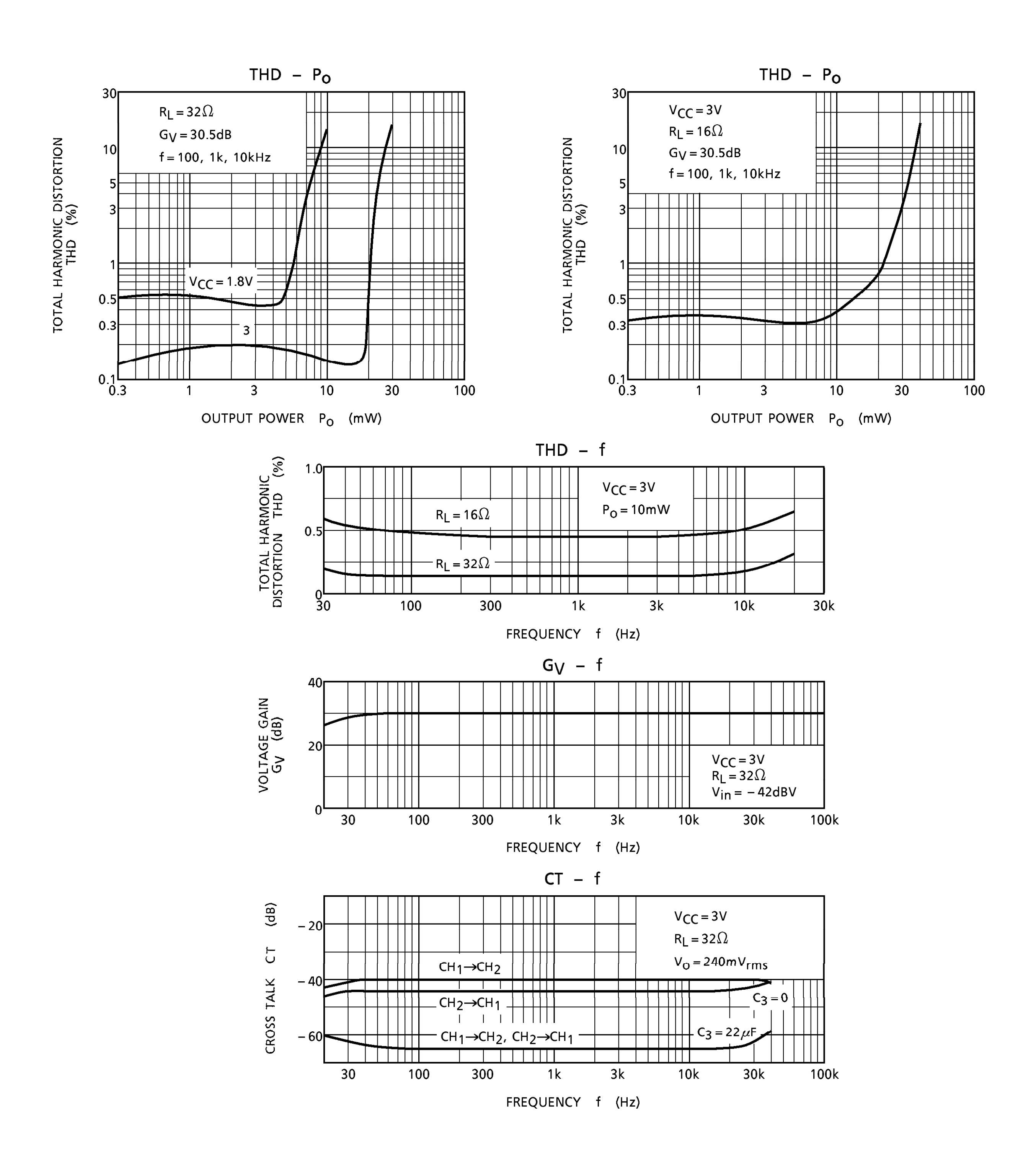
V_{CC} = 3V, $R_L = 32\Omega$; I_{CCQ}; V_{RF}; V_7 & V_{10}

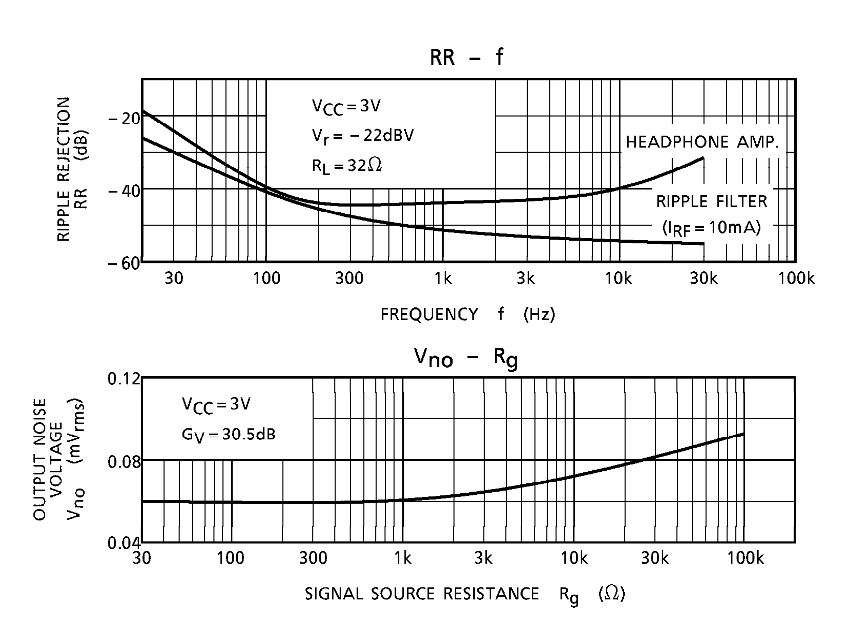
QUIESCENT CURRENT I_{CCQ} (mA) / OUTPUT TERMINAL VOLTAGE V_7 & V_{10} (V) / RIPPLE FILTER OUTPUT VOLTAGE V_{RF} (V) / AMBIENT TEMPERATURE Ta (°C)

P_o, G_V – Ta

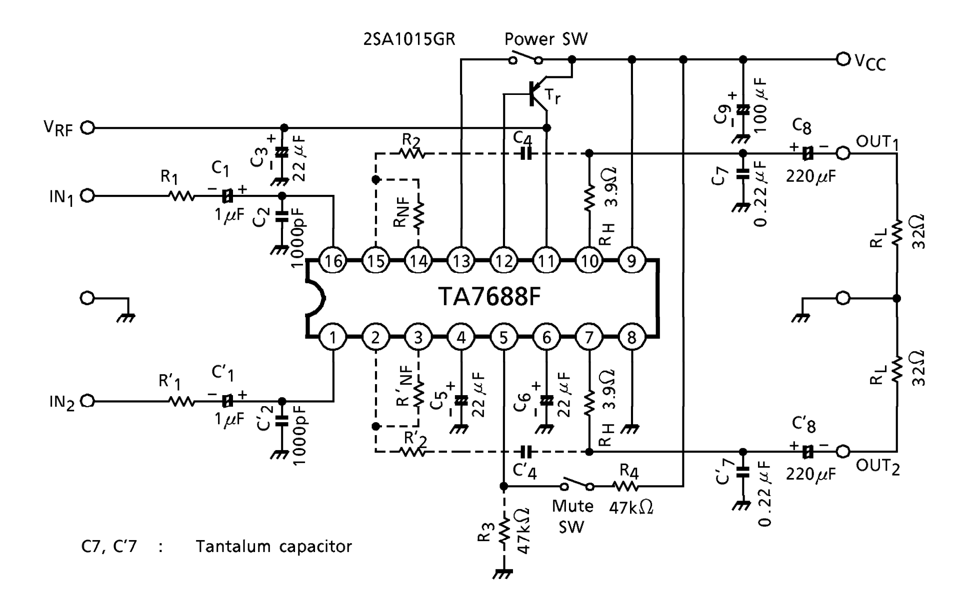
V_{CC} = 3V, $R_L = 32\Omega$, f = 1kHz; G_V; P_o

OUTPUT POWER P_o (mW) / VOLTAGE GAIN G_V (dB) / AMBIENT TEMPERATURE Ta (°C)


THD – Po
$R_L = 32\Omega$
$G_V = 30.5dB$
f = 100, 1k, 10kHz
$V_{CC} = 1.8V$
3
TOTAL HARMONIC DISTORTION THD (%)
OUTPUT POWER Po (mW)
THD – Po
$V_{CC} = 3V$
$R_L = 16\Omega$
$G_V = 30.5dB$
f = 100, 1k, 10kHz
TOTAL HARMONIC DISTORTION THD (%)
OUTPUT POWER Po (mW)
THD – f
$V_{CC} = 3V$
$P_O = 10mW$
$R_L = 16\Omega$
$R_L = 32\Omega$
TOTAL HARMONIC DISTORTION THD (%)
FREQUENCY f (Hz)
GV – f
$V_{CC} = 3V$
$R_L = 32\Omega$
$V_{in} = -42dBV$
VOLTAGE GAIN GV (dB)
FREQUENCY f (Hz)
CT – f
$V_{CC} = 3V$
$R_L = 32\Omega$
$V_O = 240mV_{rms}$
CH1→CH2
CH2→CH1
$C_3 = 0$
CH1→CH2, CH2→CH1
$C_3 = 22\mu F$
CROSS TALK CT (dB)
FREQUENCY f (Hz)



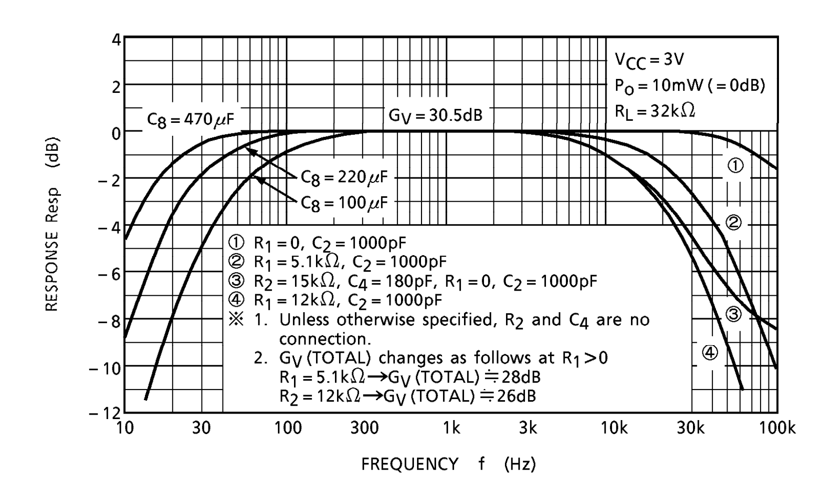
APPLICATION CIRCUIT

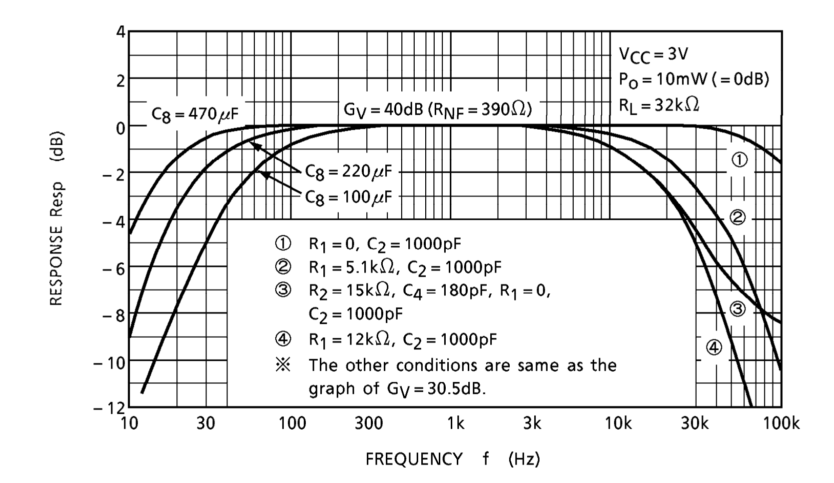


EXTERNAL PARTS TABLE (Mention only CH_1)

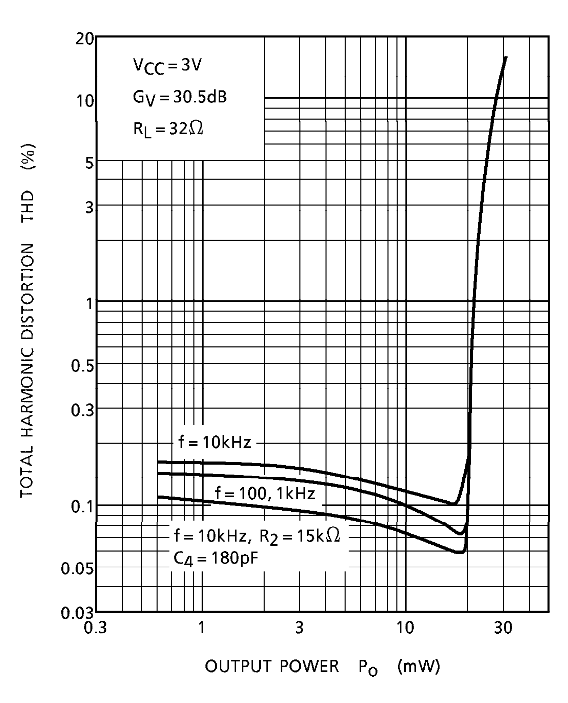
PARTS No.	TYPICAL	PURPOSE	INFLUENCE: SMALLER THAN TYP.	INFLUENCE: GREATER THAN TYP.	NOTE
C_1	$1\mu F$	Coupling	Bad low frequency response	"P_{op}" noise is high.	Input
C_2	1000pF	LPF	$f_{CH} = \frac{1}{2\pi C_2 (R_1 // Z_{in})}$		Noise receiving protection
R_1	—	LPF	−3dB (30kHz) at $R_1 = 5.6k\Omega$ −3dB (20kHz) at $R_1 = 12k\Omega$		Equivalent signal source impedance
C_3	$22\mu F$	Decoupling for V_{RF}	Stability (OSC) decreases, V_{no} at V_{RF} increases	(It is better to connect to input side GND)	Use tantalum capacitor
R_{NF}	—	G_V Adjustment	Not available at $G_V < 30dB$ If necessary devide at input level by resistors		—
R_2 C_4	(15kΩ) (180pF)	f-response control, THD imperovement at high freq.	−3dB point is 20kHz. Check ringing at clip by OSC margine down.		Low OSC margine at $G_V < 40dB$
C_5	$22\mu F$	Bypass capacitor for bias	THD and V_{no} Degradation	—	It is better to connect to input side GND.
C_6	$22\mu F$	Bypass capacitor for ripple filter	Ripple rejection ratio degradation	—	It is better to connect to output side GND.
R_3	47kΩ	Pull down resistor at mute pin	I_{CC} increases at mute ON	Pull down effect down	Additional resistor at long pattern only
R_4	47kΩ	I_{MUTE} limiter	I_{MUTE} increases (Unnecessary at $V_{CC} = 3V$)	I_{MUTE} decreases	$I_{MUTE} < 150\mu A$
R_H	3.9Ω	Protection resistance. Phase compensation	Rush current increases. Phase compensation is out.	Output decreases. Phase compensation is out.	CR filter with C_7
C_7	$0.22\mu F$	Phase compensation	Oscillation	THD degradation by load capaci-tance	Recommended to use tantalum or film capacitor
C_8	$220\mu F$	Coupling	Bad low frequency response	"P_{op}" noise is high.	Output
C_9	$100\mu F$	V_{CC} decoupling	Oscillation margin decreases	—	Necessary to be near pin 9
T_r	2SA1015GR	Booster for V_{RF}	—	—	To be added at $I_{RF} > 10mA$

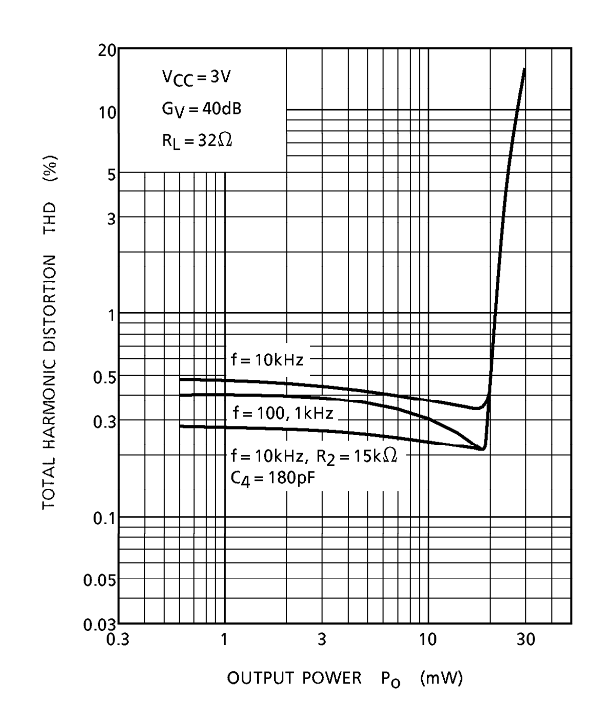
1. f-Resp (Mention Only CH_1)



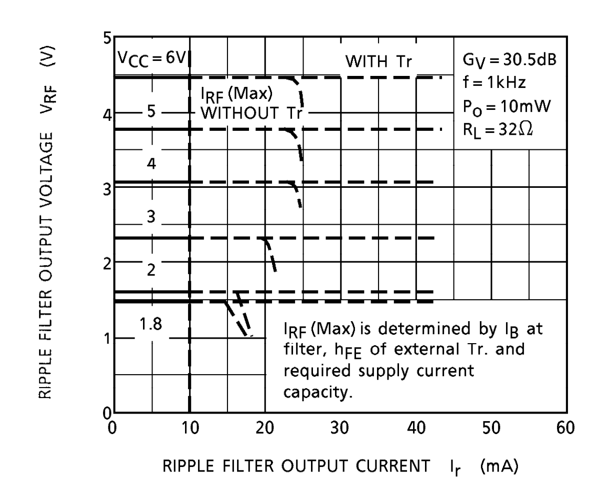


2. P_O-THD (Correspond to 1. f-Resp)





3. I_{RF}-V_{RF}

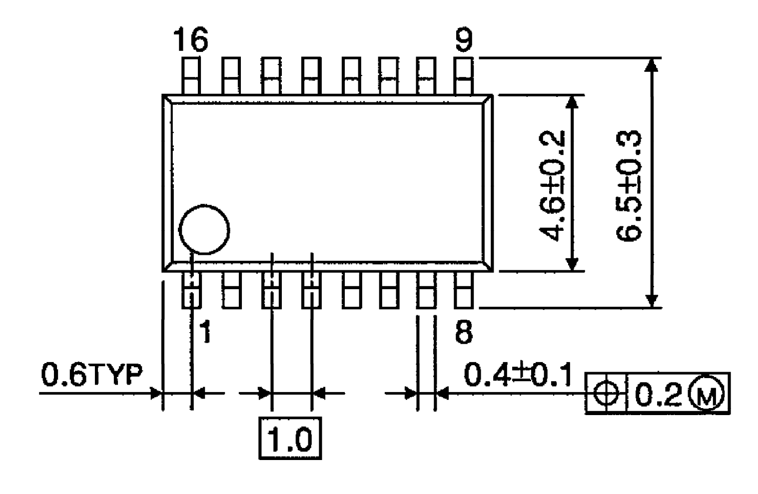


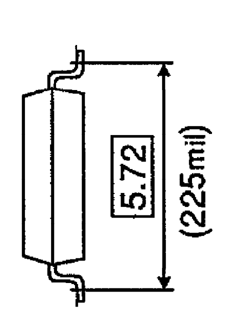


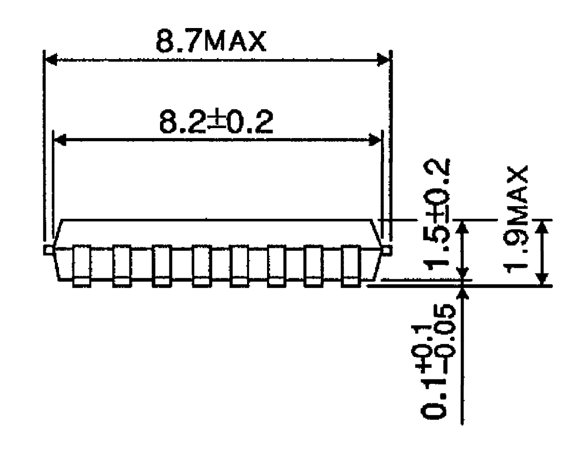
OUTLINE DRAWING

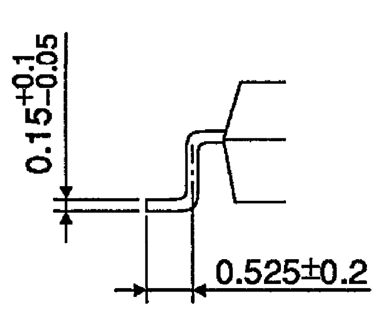
SSOP16-P-225A

Unit : mm









Weight : 0.14g (Typ.)